CURRENT PERCEPTIONS OF SPENT NUCLEAR FUEL BEHAVIOR
IN WATER POOL STORAGE

A. B. Johnson, Jr.
Staff Scientist
Corrosion Research and Engineering

MASTER

June 1977

To be presented at the American Nuclear Society Meeting,
San Francisco, CA. November 27 - December 2, 1977.

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
UNDER CONTRACT EY-76-C-06-1830

BATTELLE
Pacific Northwest Laboratories
Richland, Washington 99352

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CURRENT PERCEPTIONS OF SPENT NUCLEAR FUEL BEHAVIOR IN WATER POOL STORAGE

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Storage of spent nuclear fuel has recently become an important issue, due to delays in access to reprocessing and recent uncertainties in the eventual status of reprocessing. Water pools are currently the only available option for interim storage of spent fuel. The extension and expansion of spent fuel storage in water pools has raised questions regarding the integrity of spent fuel in extended storage. Battelle's Pacific Northwest Laboratories surveyed a cross section of the U.S. and Canadian fuel storage pool operators to define their perceptions of spent fuel behavior, and to establish the range of pool storage environments. The survey addressed the numbers and types of fuel bundles in storage, the maximum pool residences and burnups, fuel bundle and pool equipment materials, pool water chemistries, mechanical damage during fuel handling, and storage characteristics of failed and intact fuel.

The numbers of stored fuel bundles, maximum residence times and burnups are summarized in Table 1 for stainless steel- and Zircaloy-clad fuel.

Based on visual inspections and radioactivity monitoring of pool water, there is no evidence that fuel bundle materials have degraded significantly due to corrosion. However, no detailed fuel examinations have been conducted to verify fuel integrity and to determine whether one or more degradation mechanisms are discernible.

Fuel handling operations appear to cause minimal mechanical damage to the fuel. Over the period 1974 to 1976 only nine incidents have appeared which involve dropping fuel bundles; only two resulted in gas releases.

Several types of defects have developed in the cladding during reactor exposures, including pin-holes and cracks which expelled gases to the primary coolant. Some defects involve breaks in the cladding,

with exposed pellets. Special equipment has been developed to handle failed fuel in pool storage, including metal hoods to channel radioactive gases to the cleanup system, and closed canisters to isolate the fuel from pool water. However, most fuel bundles with defects generally are stored without special procedures. Failed fuel has been stored, handled, and reprocessed without substantial difficulty.

Apparent successful storage of fuel up to 18 years and relatively benign water chemistries suggest that longer fuel storage in water pools is a reasonable extension of current technology. However, selected, detailed analyses of stored fuel with and without defects is needed to develop assurances that fuel integrity will be satisfactory in long-term exposures.

The range of fuel pool storage conditions is summarized in Table 2. A preliminary study is underway to relate the storage conditions to known corrosion regimes for fuel bundle materials.

Table 1. Spent Fuel Storage Summary

Stored Fuel Inventory - End of 1976

Canadian Fuel	~70,000 Bundles ^{a)}
U.S. Fuel	~ 8,675 Bundles ^{b)}

Maximum Fuel Residence in Pools

Canadian Fuel:

25 Bundles - Zircaloy - 1962/63 Chalk River

U.S. Fuel:

1 Bundle - Zircaloy - 1959 ECF/Idaho

6 Bundles - Zircaloy - 1964 ECF/Idaho

25 Bundles - Stainless Steel - 1970 GE-Morris

Maximum Burnups on Stored Fuel

Bundles - Stainless Steel	300,000 Mwd/MTU (Max) ^{c)}
Bundles - Stainless Steel	33,000 Mwd/MTU (Max)
Bundles - Zircaloy	33,000 Mwd/MTU (Max)

a) Bundle length ~0.5 m; Zircaloy cladding

b) Bundle length ~4 m; stainless steel and Zircaloy cladding

c) High ²³⁵U enrichment; fuel reprocessed in 1970, was in pool storage 3.5 y

Table 2. Summary of Fuel Storage Conditions

Temperature Range:

Bulk Water	70 to 120°F (20 to 50°C)
Fuel Surface T	1 to 10°C

Radiation Levels:

Fresh Fuel Surface	$10^5 - 10^6$ R/hr
Aged Fuel Surface (4y)	300 R/hr

Water Chemistries:

- a) Oxygen-saturated deionized water
- b) Oxygen-saturated boric acid^{a)}

Materials:

Fuel Cladding	Stainless Steel or Zircaloy
Storage Canisters	Stainless Steel or Aluminum
Pool Liners	Stainless Steel, Epoxy, Fiber Glass

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- a) Pressurized water reactor pools